Notice of Allowability	Application No.	Applicant(s)	
	10/517,090	TSATSANIS ET AL.	
	Examiner	Art Unit	
	Sam K. Ahn	2611	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address--

All claims being allowable, PROSECUTION ON THE MERITS IS (OR REMAINS) CLOSED in this application. If not included herewith (or previously mailed), a Notice of Allowance (PTOL-85) or other appropriate communication will be mailed in due course. **THIS NOTICE OF ALLOWABILITY IS NOT A GRANT OF PATENT RIGHTS.** This application is subject to withdrawal from issue at the initiative of the Office or upon petition by the applicant. See 37 CFR 1.313 and MPEP 1308.

1. ☒ This communication is responsive to *10/30/07*.

2. ☒ The allowed claim(s) is/are *8,10-12,20,22-24,43 and 45-47, renumbered as 1-12, respectively*.

3. ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
   a) ☐ All b) ☐ Some* c) ☐ None of the:
      1. ☐ Certified copies of the priority documents have been received.
      2. ☐ Certified copies of the priority documents have been received in Application No. _____ .
      3. ☐ Copies of the certified copies of the priority documents have been received in this national stage application from the International Bureau (PCT Rule 17.2(a)).

   * Certified copies not received: _____.

Applicant has THREE MONTHS FROM THE "MAILING DATE" of this communication to file a reply complying with the requirements noted below. Failure to timely comply will result in ABANDONMENT of this application.
THIS THREE-MONTH PERIOD IS NOT EXTENDABLE.

4. ☐ A SUBSTITUTE OATH OR DECLARATION must be submitted. Note the attached EXAMINER'S AMENDMENT or NOTICE OF INFORMAL PATENT APPLICATION (PTO-152) which gives reason(s) why the oath or declaration is deficient.

5. ☐ CORRECTED DRAWINGS (as "replacement sheets") must be submitted.
   (a) ☐ including changes required by the Notice of Draftsperson's Patent Drawing Review (PTO-948) attached
      1) ☐ hereto or 2) ☐ to Paper No./Mail Date _____.
   (b) ☐ including changes required by the attached Examiner's Amendment / Comment or in the Office action of Paper No./Mail Date _____.

   Identifying indicia such as the application number (see 37 CFR 1.84(c)) should be written on the drawings in the front (not the back) of each sheet. Replacement sheet(s) should be labeled as such in the header according to 37 CFR 1.121(d).

6. ☐ DEPOSIT OF and/or INFORMATION about the deposit of BIOLOGICAL MATERIAL must be submitted. Note the attached Examiner's comment regarding REQUIREMENT FOR THE DEPOSIT OF BIOLOGICAL MATERIAL.

Attachment(s)

1. ☒ Notice of References Cited (PTO-892)
2. ☐ Notice of Draftperson's Patent Drawing Review (PTO-948)
3. ☐ Information Disclosure Statements (PTO/SB/08), Paper No./Mail Date _____
4. ☐ Examiner's Comment Regarding Requirement for Deposit of Biological Material
5. ☐ Notice of Informal Patent Application
6. ☒ Interview Summary (PTO-413), Paper No./Mail Date *20071107* .
7. ☒ Examiner's Amendment/Comment
8. ☒ Examiner's Statement of Reasons for Allowance
9. ☐ Other _____.

EXAMINER'S AMENDMENT

An examiner's amendment to the record appears below. Should the changes and/or additions be unacceptable to applicant, an amendment may be filed as provided by 37 CFR 1.312. To ensure consideration of such an amendment, it MUST be submitted no later than the payment of the issue fee.

Authorization for this examiner's amendment was given in a telephone interview with Mr. Joseph Jordan on 11/7/07.

The application has been amended as follows:

Claims 1-7 (Canceled).

8. A method comprising:

creating a communications line with two or more twisted copper pairs of wire in one or more binders;

receiving from said two or more twisted pairs across two or more receivers physical layer signals that have been coordinated across two or more transmitters; ~~and~~

exploiting a correlation between measured interference noise values across two or more of said receivers to reduce interference noise in the physical layer signals; and

maximizing a SNR (Signal-to-Noise Ratio) in each frequency bin of one or more frequency bins across the communications line,

wherein the two or more receivers and the two or more transmitters utilize a Discrete Multi-Tone architecture having the one or more frequency bins, and

wherein the receiving physical-layer signals across two or more receivers is performed in a frequency domain, independently for each frequency bin of the one or more frequency bins, and further wherein the receiving physical-layer signals across two or more receivers comprises:

multiplying a transmitted symbol vector, whose elements are one or more individual symbols intended for each of the ~~one~~ two or more transmitters, with a MIMO

(Multiple Input Multiple Output) pre-processing matrix, to generate multiplied transmitted vectors;

sending the multiplied transmitted vectors to an IFFT (Inverse Fast Fourier Transform) for conversion into time-domain waveforms;

converting a received symbol vector into frequency-domain symbols via a FFT (Fast Fourier Transform); and

multiplying the frequency domain symbols with a MIMO post-processing matrix

wherein the MIMO pre-processing matrix and the MIMO post-processing matrix are designed separately for each frequency bin of the one or more frequency bins,

9. (Canceled).

10. The method of claim.[[9]] 8, further comprising designing the MIMO post-processing matrix used in each frequency bin of the one or more frequency bins to perform

pre-whitening the interference noise across the communications line, and

acting as a matrix FEQ (Frequency Equalizer) to equalize effects of a shortened multiline communications channel on the transmitted symbol vector.

11. The method of claim 10, wherein the pre-whitening further comprises:

restricting the interference noise onto a subspace of a smallest possible dimension in a signal space; and

providing one or more independent directions in the signal space to be free of the interference noise.

12. The method of claim 11, further comprising designing the MIMO pre-processing matrix used in each frequency bin of the one or more frequency bins to

be Hermitian, so that a transmitted signal power across the two or more twisted copper pairs is preserved; and

yield an identity matrix when pre-multiplied by a main channel transfer matrix for a same frequency bin of the one or more frequency bins and the MIMO post-processing matrix for the same frequency bin of the one or more frequency bins.

Claims 13-19 (Canceled).

20. A system comprising:

means for creating a communications line with two or more twisted copper pairs of wire in one or more binders;

means for receiving from said two or more twisted pairs across two or more receivers physical layer signals that have been coordinated across two or more transmitters; [[and]]

means for exploiting a correlation between measured interference noise values across two or more of said receivers to reduce interference noise in the physical layer signals; and

means for maximizing a SNR (Signal-to-Noise Ratio) in each frequency bin of one or more frequency bins across the communications line,

wherein the two or more receivers and the two or more transmitters utilize a Discrete Multi-Tone architecture having the one or more frequency bins, and

wherein the means for receiving the physical-layer signals across two or more receivers is performed in a frequency domain, independently for each frequency bin of the one or more frequency bins, and further wherein means for receiving physical-layer signals across two or more receivers comprises:

means for multiplying a transmitted symbol vector, whose elements are one or more individual symbols intended for each of the ~~one~~ two or more transmitters, with a MIMO (Multiple Input Multiple Output) pre-processing matrix, to generate multiplied transmitted vectors;

means for sending the multiplied transmitted vectors to an IFFT (Inverse Fast Fourier Transform) for conversion into time-domain waveforms;

means for converting a received symbol vector into frequency-domain symbols via a FFT (Fast Fourier Transform); and

means for multiplying the frequency domain symbols with a MIMO post-processing ~~mix~~ matrix

wherein the MIMO pre-processing matrix and the MIMO post-processing matrix are designed separately for each frequency bin of the one or more frequency bins.

21. (Canceled).

22. The system of claim [[21]] 20, further comprising means for designing the MIMO post-processing matrix used in each frequency bin of the one or more frequency bins to perform

pre-whitening the interference noise across the communications line, and

acting as a matrix FEQ (Frequency EQualizer) to equalize effects of a shortened multiline communications channel on the transmitted symbol vector.

23. The system of claim 22, wherein means for pre-whitening further comprises:

means for restricting the interference noise onto a subspace of a smallest possible dimension in a signal space; and

means for providing one or more independent directions in the signal space to be free of the interference noise.

24. The system of claim 23, further comprising means for designing the MIMO pre-processing matrix used in each frequency bin of the one or more frequency bins to

be Hermitian, so that a transmitted signal power across the two or more twisted copper pairs is preserved; and

yield an identity matrix when pre-multiplied by a main channel transfer matrix for a same frequency bin of the one or more frequency bins and the MIMO post-processing matrix for the same frequency bin of the one or more frequency bins.

Claims 25-42 (Canceled).

43. A system comprising:

a communications line with two or more twisted copper pairs of wire in one or more binders;

two or more receivers coupled to the communications line;

two or more transmitters coupled to the communications line;

physical-layer signals coordinated across the two or more twisted copper pairs of wire by the two or more transmitters and received from said two or more copper pairs across the two or more receivers; and

the two or more receivers reducing interference noise by exploiting a correlation between measured interference noise values across the two or more receivers,

wherein the reduced interference noise includes out of domain components of interference noise, and

wherein the two or more receivers and two or more transmitters utilize a Discrete Multi-Tone architecture having one or more frequency bins, and

wherein the physical-layer signals are received in a frequency domain,

independently for each frequency bin of the one or more frequency bins, and

further wherein the two or more receivers:

multiply a transmitted symbol vector, whose elements are one or more individual symbols intended for each of the ~~one~~ two or more transmitters, with a MIMO (Multiple Input Multiple Output) pre-processing matrix, to generate multiplied transmitted vectors;

send the multiplied transmitted vectors to an IFFT (Inverse Fast Fourier Transform) for conversion into time-domain waveforms;

convert a received symbol vector into frequency-domain symbols via a FFT (Fast Fourier Transform); and

multiply the frequency domain symbols with a MIMO post-processing matrix,

wherein the two or more receivers maximize a SNR (Signal-to-Noise Ratio) in each frequency bin of the one or more frequency bins across the communications line,

wherein the MIMO pre-processing matrix and the MIMO post-processing matrix are designed separately for each frequency bin of the one or more frequency bins.

44. (Canceled).

45. A system comprising:

a communications line with two or more twisted copper pairs of wire in one or more binders;

two or more receivers coupled to the communications line;

two or more transmitters coupled to the communications line;

physical-layer signals coordinated across the two or more twisted copper pairs of wire by the two or more transmitters and received from said two or more copper pairs across the two or more receivers; and

the two or more receivers reducing interference noise by exploiting a correlation between measured interference noise values across the two or more receivers,

wherein the two or more receivers and two or more transmitters utilize a Discrete Multi-Tone architecture having one or more frequency bins, and

wherein the physical-layer signals are received in a frequency domain, independently for each frequency bin of the one or more frequency bins, and

further wherein the two or more receivers:

multiply a transmitted symbol vector, whose elements are one or more individual symbols intended for each of the ~~one~~ two or more transmitters, with a MIMO (Multiple Input Multiple Output) pre-processing matrix, to generate multiplied transmitted vectors;

send the multiplied transmitted vectors to an IFFT (Inverse Fast Fourier Transform) for conversion into time-domain waveforms;

convert a received symbol vector into frequency-domain symbols via a FFT (Fast Fourier Transform); and

multiply the frequency domain symbols with a MIMO post-processing matrix, and

wherein the two or more receivers maximize a SNR (Signal-to-Noise Ratio) in each frequency bin of the one or more frequency bins across the communications line, wherein the MIMO pre-processing matrix and the MIMO post-processing matrix are designed separately for each frequency bin of the one or more frequency bins, and

wherein the MIMO post-processing matrix used in each frequency bin of the one or more frequency bins pre-whiten the interference noise across the communications line, and act as a matrix FEQ (Frequency Equalizer) to equalize effects of a shortened multiline communications channel on the transmitted symbol vector.

46. The system of claim 45, wherein the two or more receivers restrict the interference noise onto a subspace of a smallest possible dimension in a signal space; and

provide one or more independent directions in the signal space to be free of interference noise.

47. The system of claim 46, wherein the MIMO pre-processing matrix used in each frequency bin of the one or more frequency bins are Hermitian, so that a transmitted signal power across the two or more twisted copper pairs is preserved; and

yield an identity matrix when pre-multiplied by a main channel transfer matrix for a same frequency bin of the one or more frequency bins and the MIMO post-processing matrix for the same frequency bin of the one or more frequency bins.

Claims 48-57 (Canceled).

The following is an examiner's statement of reasons for allowance: present application discloses a system employing DMT scheme minimizing interferences in signals transmitted over twisted copper wire. Prior art teaches all subject matter claimed. However, prior art does not explicitly teach receiving the signals that has been

multiplied with a transmitter MIMO processing matrix provided to an inverse fast Fourier transform, which then is coupled to a fast Fourier transform and to a receiver MIMO processing matrix during the receiving of the physical layer signals received over the twisted copper wire by receivers in the system wherein the MIMO processing matrices are designed separately for each frequency bin, in combination with the limitation of exploiting a correlation between measured interference noise to reduce interference noise in the physical layer signals and maximizing SNR in the each frequency bin.

Any comments considered necessary by applicant must be submitted no later than the payment of the issue fee and, to avoid processing delays, should preferably accompany the issue fee. Such submissions should be clearly labeled "Comments on Statement of Reasons for Allowance."

The prior art made of record and not relied upon is considered pertinent to applicant's disclosure.

Tehrani et al. An Implementation of Discrete Multi-Tone over Slowly Time-varying Multiple-Input / Multiple-Output Channels, 1998, IEEE, p.2806-2811 teach transmission of data over MIMO channels using MIMO DMT scheme.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Sam Ahn whose telephone number is (571) 272-3044. The examiner can normally be reached on Monday-Friday.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Mohammad Ghayour can be reached on (571) 272-3021. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

Sam K. Ahn
Patent Examiner

11/7/07